Urban to Regional Scale Exterior Modeling

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Objectives: Our goal is to develop urban to regional scale atmospheric models for accurately assessing CB agent plume transport over 10's to 100's of kilometers. These models compute the flow and dispersion on the outer "nested" domain and are used to "drive" the high resolution building-scale CFD models (see previous abstract). Our models need to account for urban effects and so we have incorporated urban canopy parameterizations into the regional scale COAMPS meteorological model and have modified the urban mesoscale HIGRAD model so that it is capable of simulating both atmospheric and building-type flows. Validation is a major objective and will be addressed, in part, through a multi-agency urban field experiment (see earlier abstract). In addition to deploying high fidelity atmospheric models, we are developing, testing, and validating fast response models with urban physics for use in a chem-bio emergency response system. Our intent is to use the suite of models described above for real applications. Currently, we are helping the BASIS DDAP team with vulnerability assessments and sensor siting requirements for the Winter Olympics and the M&P Field Experiment team with pre-calculations of wind fields and tracer transport.

FY00 Progress:

Urban Canopy Parameterizations. The transport of chem-bio agents over large distances must be handled by regional atmospheric codes; these codes, however, cannot "see" the buildings of a city explicitly because the spatial resolution, or grid size, of the models is on the order of kilometers. We have developed urban canopy parameterizations that allow the atmospheric models to "feel" the effect of the buildings without explicitly resolving them by adding drag to the momentum equations, mechanical turbulence production to the turbulent kinetic energy and turbulent length scale equations, anthropogenic and roof heat to the temperature equation, attenuation and trapping due to buildings to the short and longwave radiation equations, and urban landuse properties to the surface energy budget equation (Brown and Williams, 1998). These urban parameterizations have been incorporated into COAMPS, the prognostic atmospheric code in the CB-ARAC emergency response atmospheric dispersion modeling system. As shown in **Figure 1**, puff dispersion calculations performed in the Salt Lake City basin are extremely sensitive to the urban canopy parameterization. This past year, Chin et al. (2000) have improved the urban canopy parameterization to better account for roof cooling and heating. In addition, a review paper surveying the use of urban canopy parameterizations in mesoscale models was completed (Brown, 2000). Validation efforts are ongoing and will utilize the results from the SLC urban field experiment.

Urban databases. For implementation of the urban canopy parameterizations, urban landuse must be correlated with building morphology. We have obtained or are in the process of obtaining building datasets and high resolution land use for Salt Lake City, Los Angeles, and Phoenix and have performed analyses that will help improve the urban parameterizations (Brown

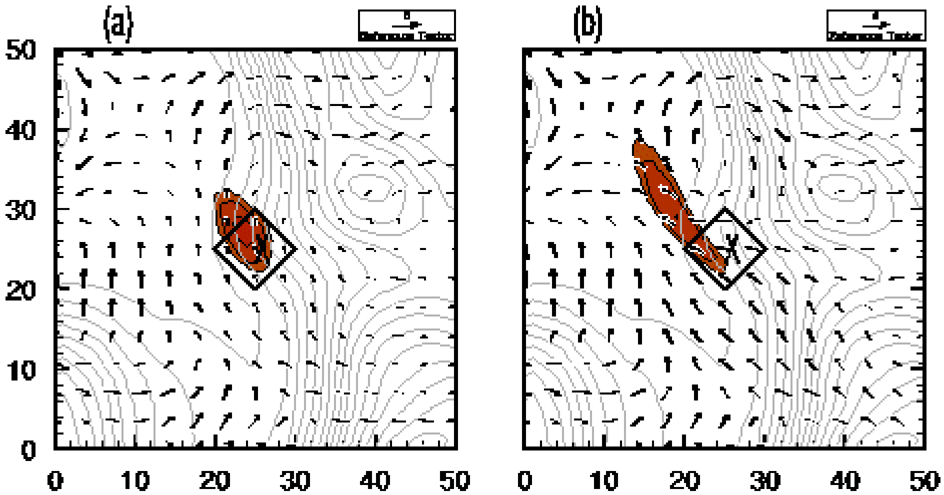

Figure 1. COAMPS/LODI plume dispersion simulation a) with and b) without the urban canopy parameterization. As can be seen, accounting for the influence of buildings on the transport and dispersion of the toxic plume will be essential for accurate assessment of CB terrorist attacks in urban environments. The coordinate axes are in kilometers.

et al., 2000 & Burian and Brown, 2000). In addition, the building datasets are being utilized by the building-scale modelers for high resolution runs.

Fast response modeling. We are developing a fast-response urban wind field model that will compute the flow around building clusters (Pardyjak and Brown, 2000). The model is based on mass conservation and analytical algorithms, hence it will have lower accuracy than a CFD model, but it will run in a mere fraction of the time, making it suitable for the CB-ARAC emergency response system. Currently the model is being converted from 2-d to 3-d and algorithms are being implemented for various building geometries and configurations. In addition, we are testing the U.K. Urban Dispersion Model (UDM), a fast response puff dispersion model that accounts for buildings through empirical algorithms, by comparing it to higher fidelity CFD model simulations. In addition, we are improving the USEPA INPUFF dispersion model by incorporating urban parameterizations.

Applications. We are performing linked COAMPS mesoscale simulations and HIGRAD basin-wide simulations in order to help with pre-planning for the Salt Lake City urban field experiment. These simulations will help determine, among other things, where to best place instruments, where and when to release tracers, and how much tracer to release. In addition, we have been using a suite of fast response models to perform hundreds of simulations for the BASIS DDAP in order to determine the minimum amount of agent that would need to be released at a given location to set-off the sensor. Calculations have been performed under various meteorological conditions with a Gaussian plume model, the INPUFF puff dispersion model, and the UDM urban dispersion model (see **Figure 2**).

Future Outlook: Our emphasis is progressing from research and development towards applications and implementation. This summer LANL and LLNL efforts will be focused on pre-planning simulations for the SLC field experiment. “Nested” simulations will cover the building scale all the way out to the mesoscale and will help the field experimentalists visualize the expected outcomes of tracer releases. Validation and testing will play a major role in the coming year. We will utilize the mesoscale to urban scale data being collected as part of the VTMX-

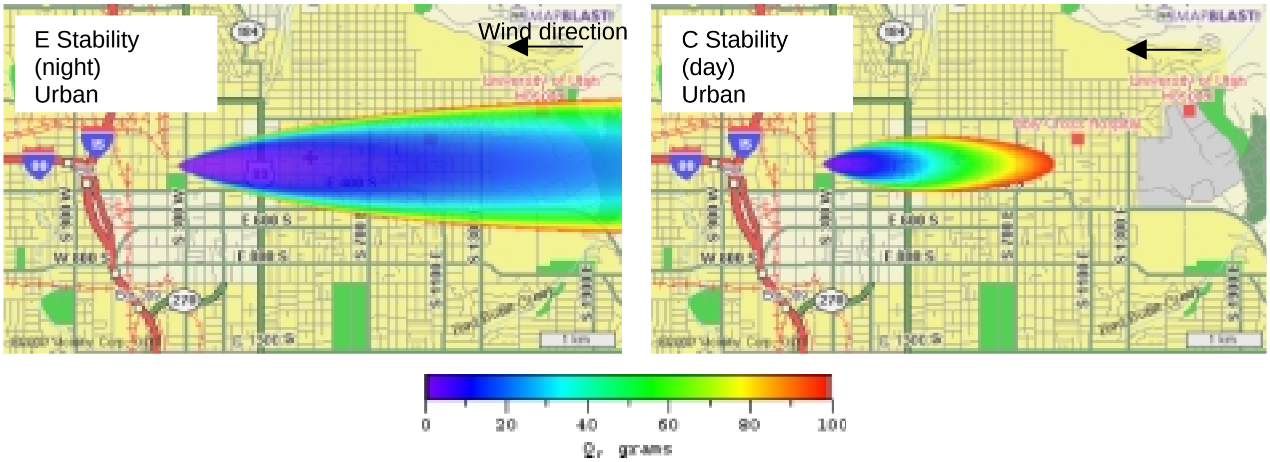

Figure 2. Contour maps showing minimum quantity of agent needed to set-off a sensor for two different atmospheric conditions. Footprints like these will help the BASIS DDAP team site and space sensors. Simulations are currently being performed with higher fidelity models as well.

URBAN field experiment to test the model parameterizations. In addition, we will use CFD model results of building clusters to assess the accuracy of our urban canopy parameterizations. In the area of fast response modeling, we plan to have a working 3-d prototype urban wind field generator by the end of year. In the coming year we will also support the BASIS DDAP team with sensor layout and consequence assessment issues. In this regard, we will devote more resources to operations, through implementation of codes or libraries of databases into the CB-ARAC and BASIS framework. Finally, we will continue working on urban database issues, which are important inputs to all models.

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